HIGHWAY RESEARCH REPORT

A COMPARISON OF TRANSVERSE WEAKENED PLANE JOINTS FORMED BY SAWING AND BY PLASTIC INSERT

INTERIM REPORT

STATE OF CALIFORNIA

BUSINESS AND TRANSPORTATION AGENCY

DEPARTMENT OF TRANSPORTATION

DIVISION OF HIGHWAYS

TRANSPORTATION LABORATORY

RESEARCH REPORT

CA-DOT-TL-5254-1-73-26

Prepared in Cooperation with the U.S. Department of Transportation, Federal Highway Administration September, 19/

TECHNICAL REPORT STANDARD TITLE PAGE

1. REPORT NO.	2. GOVERNMENT ACCESSION NO.	3. RECIPIENT'S CATALOG NO.
4. TITLE AND SUBTITLE A Comparison of Transverse Weakened Plane Joints Formed by Sawing and by Plastic Insert		5. REPORT DATE September 1973 6. PERFORMING ORGANIZATION CODE 19503-635254
7. AUTHOR(S) Neal, B. F., Howard, D. D., Woodstrom, J. H. and Spellman, D. L.		8. PERFORMING ORGANIZATION REPORT NO. CA-DOT-TL-5254-1-73-26
9. PERFORMING ORGANIZATION NAME AND ADDRESS Transportation Laboratory 5900 Folsom Blvd. Sacramento, California 95819		10. WORK UNIT NO. 11. CONTRACT OR GRANT NO. D-5-42
12. SPONSORING AGENCY NAME AND ADDRESS Department of Transportation Sacramento, California 95807		13. TYPE OF REPORT & PERIOD COVERED Interim Jan. 1972 Dec. 1972 14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

Conducted in cooperation with the U. S. Department of Transportation, Federal Highway Administration. "PCC Pavement Performance".

16. ABSTRACT

This report compares the performance of two types of weakened plane joints presently used in California -- that type formed by the plastic insert method, and that formed by sawing. A survey was made of a number of both types and defects compiled. It was found that, with proper construction techniques, either method will produce satisfactory joints. Also, with either method, many joints have undesirable defects. Changes in specifications are needed to better assure quality joints, and proposed end result type specifications are included.

17. KEY WORDS Concrete pavement construction, formed joints, sawed joints, transverse joints, specifications.	18. DISTRIBUTION STATEMENT Unlimited

19. SECURITY CLASSIF. (OF THIS REPORT)	20. SECURITY CLASSIF. (OF THIS PAGE)	21. NO. OF PAGES	22. PRICE
Unclassified	Unclassified	33	

HMRT – 1242 (ORIG. 9/72)

DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
TRANSPORTATION LABORATORY
5900 FOLSOM BLVD., SACRAMENTO 95819

September 1973

TL No. 635254
Fed. No. D-5-42

Mr. R. J. Datel
State Highway Engineer

Dear Sir:

Submitted herewith is a research report titled:

A COMPARISON OF TRANSVERSE WEAKENED PLANE JOINTS FORMED BY SAWING AND BY PLASTIC INSERT

By

B. F. Neal and D. D. Howard
Co-Investigators

J. H. Woodstrom, P. E.
Principal Investigator

Under the Supervision of
D. L. Spellman, P. E.

Very truly yours,

JOHN L. BEATON
Laboratory Director

Attachment

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)


TIMBERLINE

ACKNOWLEDGMENTS

This project was done in cooperation with the U. S. Department of Transportation, Federal Highway Administration, Agreement No. D-5-42.

INTRODUCTION

Many types of weakened plane joints have been constructed in California nonreinforced concrete pavements over the years with the sawing method receiving by far the widest application. Using a steel blade with diamond particles imbedded in the cutting edge, a cut to a depth of 2 inches or up to 25% of slab thickness is made, serving, in general, to effectively control the location of cracks. The timing of this operation is critical, especially with respect to initial saw cuts. The concrete must have strength enough to withstand ravelling tendencies of the saw blade and yet resist thermal and shrinkage stresses that induce cracking. At times the degree of success in this construction procedure leaves much to be desired.

The concrete paving industry has been seeking alternate methods of joint control, preferably at a lower cost than sawing. After considerable effort, a machine was developed to install a semi-rigid plastic strip into fresh concrete a short distance behind the slipform paver. (See Figures 1 through 4). An evaluation of the new technique was reported in January 1968[1]. Specifications[2] were developed allowing the new procedure as an alternative to sawed joints and usage became quite widespread.

CONCLUSIONS

Based on the investigation reported herein, and California PCC pavement construction procedures, the following conclusions are considered warranted.

1. Satisfactory joints can be constructed by either sawing the hardened concrete or by inserting a plastic strip in the fresh concrete.

2. Regardless of the method of construction, many joints have undesirable defects.

3. While each method has its advantages and disadvantages, neither can be considered superior to the other.

4. The skill, knowledge and experience of joint equipment operators are as important as the condition of the equipment in obtaining quality joints.

5. Changes in specifications are needed to assure better joints.

PLASTIC INSERT JOINTS

To evaluate the condition of transverse weakened plane joints formed by plastic inserts, eight completed projects, ranging in age from one month to five years and scattered throughout the state, were selected for study. On all projects the longitudinal joint was also formed by plastic insert.

Evaluation Procedure

Before starting the study, the following procedure was established but, as will be discussed later, some minor modifications were made to accommodate conditions encountered in the field.

1. Inspect construction profilograms, and if possible, select areas that show deformations caused by joint construction, and areas that show no deformations. If deformations do not show on profilograms, select areas by visual observation of the job.

2. In an area selected as average or typical of the project, assess 50 consecutive joints as to transverse alignment, depth of insert, height of bump or depth of depression at joint, amount of spalling, and alignment of longitudinal joint insert at junction with transverse insert.

3. In an area selected as good, assess 20 consecutive joints as above.

4. In an area selected as bad, assess 20 consecutive joints as above.

5. In a superelevation area, check with a straightedge, 10 consecutive joints on both the high and low side.

6. On areas having the steepest grades, check, with a straightedge, 10 joints where paving was done in the downgrade direction, and 10 joints where paving was done upgrade.

7. Using the Road Meter with strip-chart recorder, obtain graphs representing car movements over pavement sections operating at speed determined best for detecting roughness (15-20 mph in 1969 Ford).

Notes

a. Only the outer lane is to be considered, with pavements placed in widths less than 24 feet to be avoided if possible.

b. Alignment of both transverse and longitudinal inserts will be marked as either more(+) or less(-) than 0.1 foot out of alignment.

c. Straightedge measurements will be made in the outer wheel track with a 4-foot straightedge.

d. Measure total length of spalling per joint.

e. Rate spalling as follows, using photographs as guide. (See Figures 5 through 9.)

0 - None
1 - Minor
2 - Moderate
3 - Major
X - Incipient (crack evident but no actual spalling)

f. Note any other defects for possible future investigation.

Project Locations

1. 03-Sac-80, between Sacramento and Roseville.

One month old, not open to traffic. Mostly on tangent alignment with only slight grades. Very smooth riding.

2. 11-SD-805, between Highways 163 and 52.

Three months old, not opened to traffic. Mostly on tangent alignment with medium grades. Moderate amount of spalling and noticeable roughness on grades. Remainder of project is smooth riding.

3. 06-Ker-5, between Highways 99 and 119 approximately 24 miles.

Six months old, not opened to traffic. On tangent alignment, with grades only at structures. Very smooth riding.

4. 11-SD-805, between Highway 52 and Miramar Road.

Eight months old, not opened to traffic. On tangent alignment with medium grades. Slight spalling and noticeable roughness on grades. Remainder of project is smooth riding.

5. 11-SD-805, near Chula Vista.

Fourteen months old, open to local traffic. Tangent alignment with medium grades. Smooth riding except for slight roughness on grades.

6. 02-Sis-5, near Yreka.

Eighteen months old, open to traffic. Numerous curves and fairly steep grades. Moderate spalling. Most of the project is rough riding.

7. 03-ED-50, East of Sacramento.

Eighteen months old, open to traffic. Some curves and steep grades. Moderate spalling. Rough riding on grades but satisfactory on level areas.

8. 06-Mad-152, west of Chowchilla.

Five years old; one of the first projects on which a joint inserting machine was used. Moderate spalling, very smooth riding. Has several fairly deep spalls at centerline where insertion of the transverse strip caused displacement of the longitudinal strip.

The defects found on these projects are summarized in Table 1.

OTHER PROJECTS WITH PLASTIC INSERTS

The following projects were observed during or shortly after construction and were judged only on appearance and rideability, with no measurements made.

07-LA-14, near Saugus.

Initial trouble with excessive bowing or displacement, of the longitudinal plastic strip was corrected and the finished job has a good appearance. However, in spite of every effort to prevent it, the depressions left by the inserting mechanism when operating on steeper grades can be felt when driving over them.

08-SBd-60, near Chino.

An excellent job -- the joints were hard to find even after 10 days. No bumps could be felt throughout the project.

04-Ala-680, near Fremont.

Roughness put in by the joint inserter caused the Contractor to grind transversely on the low side of almost every joint on grades. (See Figure 10.) This still did not improve the ride to any great extent.

04-CC-84, near Antioch.

Joint inserter caused excessive edge slump and left depressions in the pavement. Use was discontinued after the first day.

02-Sis-5, near Mt. Shasta.

Joint inserter caused bowing of longitudinal tape and edge slump that could not be corrected. Very harsh mix contributed to troubles. (See Figure 11.) Use of inserter was discontinued.

Discussion

Transverse weakened plane joints formed by the plastic insert method have been in general use throughout the State for over four years. It is estimated that about one-half of the transverse joints in new construction are now formed by a plastic insert. The remainder are formed by sawing.

One of the main advantages in using plastic inserts is that the weakened plane is in the concrete when it is needed, the critical time being several hours after placement. As the pavement slab enters a state of tension in the late afternoon or evening hours, the tendency for cracking exists. With the presence of the plastic strip there is no concern over exactly when the critical time period occurs as the weakened plane is already in place. The occurrence of random cracking with this type of construction is extremely rare. With plastic insert joints, there is no need for scheduling a construction operation (sawing) outside of the normal paving work day. Joints can be inspected as part of the pavement construction operation.

Cracks generally occur at an early age and at uniform intervals resulting in uniform crack widths. When compared to a saw cut the opening at the pavement surface is very small, thereby providing a minimal reservoir to trap debris and allow water to penetrate the underlying layers of the structural section. No cleaning of the joint is required. By reducing the amount of incompressible materials that may collect in a joint during cold periods, pavement "growth" and "blowups" should be minimized. In theory, more uniform crack widths should also result in better load transfer between slabs and consequent lesser deflections, a reduction in pumping, and less tendency for joints to fault. This theory was neither confirmed nor disproven during the survey; however, faulting measurements on selected sections are being continued on a periodic basis and may yield important information at a later date.

On the debit side, the plastic insert method does occasionally cause an increase in surface roughness. (See Figure 12.) This occurs primarily on grades in excess of 3% and seems to be due to either vibration causing a flow of concrete to the low side, or an inability to keep the inserting head in the same plane as the pavement. While most of these inequalities are not large enough to require remedial action, many can be felt when driven over at highway speeds. Practically all of these joints meet straightedge specifications which allow 0.02 ft. deviation in 12 ft. Also, most are either not apparent on profiles obtained with the California Profilograph, or are not counted in obtaining a profile index since a blanking band eliminates bumps of plus and minus 0.1 inch from consideration. Edge slump caused by removal of the temporary side forms of the inserting machine has been a problem on some projects. When the paving concrete has been of good workability and proper consistency, and the removal of the side forms synchronized with the forward movement of the inserting machine, no edge slump of any consequence has occurred. With some of the harsher mixes, especially those containing all crushed aggregate, the edge slump following the insertion has been severe.

Excessive displacement of the longitudinal joint insert at the intersection with the transverse insert has occurred in about half of the joints surveyed. (See Figure 13.) While this can cause a small triangle of weakness prone to spalling, only a small percentage of those surveyed had spalled to any degree.

During the part of the survey spent on active construction projects, it was found that most of the problems associated with the plastic insert joints were operational in nature and could be solved by proper adjustment of the machine and proper finishing techniques after the joint material was inserted. The quality of the finished joint is dependent not only on the capability of the operator of the machine, but also on his mechanic who must make the various adjustments.

On several projects where displacement of the longitudinal plastic insert was a problem, changing to a less elastic type plastic for the longitudinal joint and keeping it at the proper elevation has been of considerable help in alleviating the problem. On other projects, edge slump has been reduced by careful adjustment of the movable side forms. No real effort has gone into trying to reduce the inequalities in the pavement surface caused by the inserter as most of these bumps or depressions are within the present specification limit.

In spite of its drawbacks, most of the Resident Engineers on the projects surveyed preferred the plastic insert method over the sawed joints. The lack of random cracking on their projects seemed to be the dominant factor in formulation of their opinion.

The survey procedure called for the selection of study areas from construction profilograms. This proved to be an unsatisfactory method for three reasons:

1. Profilograms were usually not available at the project sites so that special trips to the District Office were necessary to locate records.

2. A considerable amount of time was required to go through the sometimes numerous rolls of records.

3. Only in a few cases could rough joint areas be located by this method.

An easier method of locating test areas was found to be the use of a strip-chart recorder working in conjunction with a Road Meter. At a speed of about 20 mph, rough areas could be felt and verified with the chart produced by the recorder. Figure 14 is an example of a pavement with roughness caused by the joint inserter. An example of a smooth area is shown in Figure 15. Since most areas were considered either "good" or "bad", depending on grade alignment, the category of "typical areas" was not used. Instead, 40 to 50 consecutive joints in each of the "good" and "bad" areas were assessed.

In superelevation areas, there was a slight flow of concrete towards the low side. This usually left slight deformations at each edge of pavement, but it is not considered to be of any serious consequence. Riding comfort did not appear to be affected, but remained dependent on whether a bump and/or depression was built in transversely.

In areas where the grade was approximately 3% or more, bumps were found at practically every joint. In all cases, these bumps or raised areas were on the down hill side and were not dependent on whether paving was in an uphill or downhill direction. Most of the straightedge measurements indicated deviations of 0.005 ft. to 0.015 ft.

On the portions of pavement surveyed, no random cracks were found. Although joint widths were not measured, there were none of excessive width noted.

SAWED JOINTS

To evaluate the condition of transverse weakened plane joints formed by sawing, eight completed projects ranging in age from three months to five years and scattered throughout the state, were selected for study.

Evaluation Procedure

After visual observation of entire project, select areas on both sides of and near to a daily construction joint, and assess 50 consecutive joints in each area for spalling, ravelling, misalignment (mismatch where blades overlap), and number of random cracks. Avoid first few days construction and special problem areas. Skip 10 joints on either side of construction joint since finishing techniques are different in this area. Rate spalling as described in the section under plastic insert joints.

On a job with paving in progress:

Check condition of sawing equipment. Determine average age of concrete when sawing is started, which joints are sawed first, and at what time sawing is discontinued for the day.

Project Locations

1. 06-Kin-5, near Kettleman City.

3 months old, on tangent alignment with only one grade at end of project. Not open to traffic but has minor spalling. Some ravelling, but no random cracks in area surveyed. Many misaligned saw cuts.

2. 10-SJ-5 near Tracy.

7 months old, mostly on tangent alignment with grades only at structures. Open to traffic with moderate spalling. Considerable ravelling, but no random cracks in area surveyed.

3. 03-Sac-50, near Sacramento.

7 months old, on tangent alignment with grades only at structures. Open to traffic with moderate to major spalling. Considerable ravelling, but no random cracks in area surveyed. Many misaligned saw cuts.

4. 03-Sac-880, near Sacramento.

16 months old, mostly on tangent alignment with grades at structures. Open to traffic with moderate spalling. Some ravelling, but no random cracks in area surveyed. Many misaligned saw cuts.

5. 11-SD-52, near San Diego.

2 years old with moderate curves and grades. Area surveyed not open to traffic but has slight spalling. No ravelling, but some random cracking.

6. 06-Ker-5, near Bakersfield.

3 years old, on tangent alignment with no grades. Open to traffic with slight spalling. Slight ravelling, but no random cracks in area surveyed.

7. 06-Ker-5, near Bakersfield.

4 years old, on tangent alignment with no grades. Open to traffic with moderate spalling. Slight ravelling and no random cracks in area surveyed.

8. 06-Mad-152, west of Chowchilla.

5 years old, on tangent alignment with no grades. Open to traffic with slight spalling. Slight ravelling with some random cracking. Many misaligned saw cuts.

Table 2 contains a summary of findings on these projects. It was hoped that the sections selected for survey would be representative of the entire project; however, it is known that each project contained random cracking to some extent, but in only two cases were cracks found in the areas surveyed.

Discussion

Forming weakened plane joints by sawing the hardened concrete has been a general practice in California for about 20 years. As with the plastic insert method, there are both advantages and disadvantages in sawing the joints. When the joints are to be sawed, the number of finishers can be held to a minimum as there is no worry about deviations being caused in the surface of the fresh concrete by joint construction procedures. Also, any type of concrete mix and any gradient can be successfully sawed with the present equipment. The depth of the saw cut can be varied as circumstances require.

The proper time for sawing is the most critical aspect of the operation. Concrete that is too green when sawed will have unsightly ravelling (see Figure 16) or lead to later ravelling and spalling due to disturbance of the partially hardened concrete. Concrete that is left too long before sawing may develop random cracking. (See Figure 17.) Under certain climatic conditions, large areas of the pavement will crack before sawing can be completed. Mismatch of multiblade saws where they overlap occasionally occur. This results in extra wide openings at that point. These joints cannot be satisfactorily sealed with voided neoprene, and they tend to collect larger size rocks and debris which leads to spalling.

Saw cuts also require additional curing measures. It is questionable whether the green concrete exposed by sawing receives adequate cure from the normally employed method of hand spraying curing compound. This could result in weaker concrete, more subject to compressive failures. Joints that are sawed and left unsealed during the remainder of the roadway construction become filled with materials from shoulder construction and other operations, leading to premature spalling or compression failures. Temporary fillers to prevent this are difficult to maintain at the proper elevation. When fillers are not used, the cleaning operation before opening to traffic is expensive and not always satisfactory.

Several projects were visited during the pavement construction phase where sawing operations were in progress. It was found that these operations varied too much between projects to establish what constitutes a typical procedure. Sawing generally started from 8 to 12 hours after placement, but depended on the concrete mix, ambient conditions, previous experience of the Resident Engineer and agreement between the Engineer and the saw operator. Usually, there is only one saw operator and he prefers to saw every joint in succession instead of skipping some and having to back up later to get the remaining ones. When this procedure is carried too far it can lead to random cracking of that portion of the slab placed between mid-morning and mid-afternoon. Most operators are knowledgeable, however, and know when to saw control joints, either every second or fourth joint, to minimize random cracking.

The time at which sawing was discontinued was also highly variable, dependent on the need for early sawing and the time when instantaneous cracks would occur with the beginning of the saw cut. In some cases, sawing could, and did, go on all night or until the days placement was completed. Usually, however, the late afternoon placement was left until the following morning.

GENERAL DISCUSSION

In this study of the two types of joints, neither type appeared to have a clear cut advantage over the other. Both had defects that could lead to more serious trouble, and both had areas of superior performance. While the average length of spalling was greater with the plastic insert joints, this could be considered offset by the ravelling of the sawed joints.

With respect to riding quality, no difference was found on level sections. However, on grades of 3% or more, pavements with sawed joints were smoother. This subjective opinion was made by observers who knew the type of joints they were driving over, the type of finishing equipment used, and the nature of the bumps to be expected. It is felt that a layman observer would have a difficult time differentiating between the "chatter" built into the pavement by some paving trains and the small depressions caused by the plastic joint inserter.

Random cracking in pavements using plastic insert joints is practically nonexistent. A pavement constructed with sawed joints and having no random cracking is the exception rather than the rule. This can and does lead to costly repairs, sometimes even before the project is open to public traffic.

The joint inserting machines and the concrete saws observed were all in relatively good condition. However, the skill, knowledge and experience of the operators are the most important variables in obtaining good joints. The number of excellent joints produced by sawing and by plastic insert indicates the capabilities of each machine. The number of defects found in this study indicates that improvement in both methods is needed.

The amount and type of corrective action taken on projects where joint construction does not fully comply with specifications is highly variable. It is concluded from this investigation that to obtain joints of the desired quality and to provide uniform corrective action for faulty joint construction, changes in present specifications are needed. A draft of proposed end result type specifications for weakened plane joint construction is included in the Appendix.

REFERENCES

1. Transverse Weakened Plane Joints by Plastic Insert, California Division of Highways, 1968.

2. California Standard Specifications, January 1973.

Table 1

PLASTIC INSERT JOINT SURVEY SUMMARY

Location Number	% Joints with Depression at Joint (in 0.000')			% Joints with Longitudinal Insert Displaced	% Joints Spalled at Longitudinal and Transverse Intersect RATING					% Transverse Joints Spalled RATING					Avg. Length of Spall Per Joint
	0-5	5-10	+10		0	1	2	3	X	0	1	2	3	X	
1	92	8	0	------	100	0	0	0	0	89	5	0	0	6	0.1'
2	94	6	0	30	93	1	1	1	4	64	2	3	17	13	0.3'
3	94	6	0	59	90	0	0	0	10	73	5	0	0	22	0.1'
4	90	9	1	49	83	3	0	0	14	34	21	1	0	43	0.2'
5	78	21	1	50	100	0	0	0	0	46	1	0	0	53	0.3'
6	51	20	29	53	26	28	16	7	23	17	60	10	0	13	0.6'
7	45	27	28	17	48	29	18	2	3	6	51	42	2	7	1.3'
8	99	1	0	97	63	11	6	4	16	30	50	13	2	6	0.3'
Avg.	80	12	8	51	75	9	5	2	9	45	24	9	3	19	0.4'

Table 2

SAWED JOINT SURVEY SUMMARY

Location Number	Time of PCC Placement	% Joints Ravelled	% Joints Misaligned	% Transverse Joints Spalled RATING 0	1	2	3	X	Average Length of Spall per Joint
1	AM	0	56	82	18	2	0	0	0.03'
	PM	24	18	86	14	0	0	2	
2	AM	88	4	18	64	26	0	6	0.2'
	PM	6	12	62	32	6	0	0	
3	AM	26	26	56	24	14	6	2	0.1'
	PM	26	66	52	28	14	6	0	
4	AM	36	26	46	28	24	2	0	0.1'
	PM	4	44	36	50	14	0	0	
5	AM	0	6	14	78	6	0	10	0.2'
	PM	0	4	58	32	2	0	14	
6	AM	12	26	68	26	4	0	2	0.1'
	PM	2	26	70	24	4	0	2	
7	AM	0	6	10	72	30	2	2	0.3'
	PM	12	34	40	56	6	0	4	
8	AM	0	30	46	46	0	2	4	0.2'
	PM	6	40	56	36	6	0	0	
Combined Average		15	26	50	39	10	2	4	0.2'

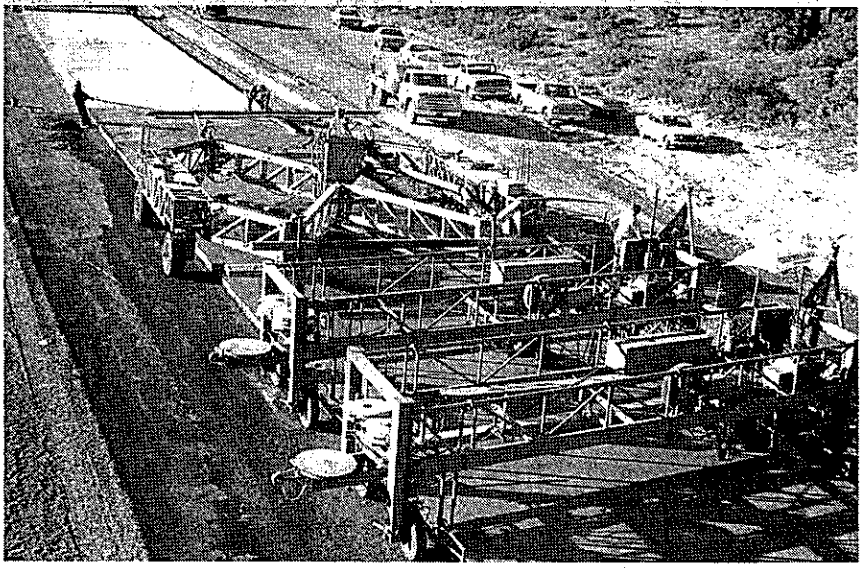

Figure 1. Two plastic joint machines followed by pipe float.

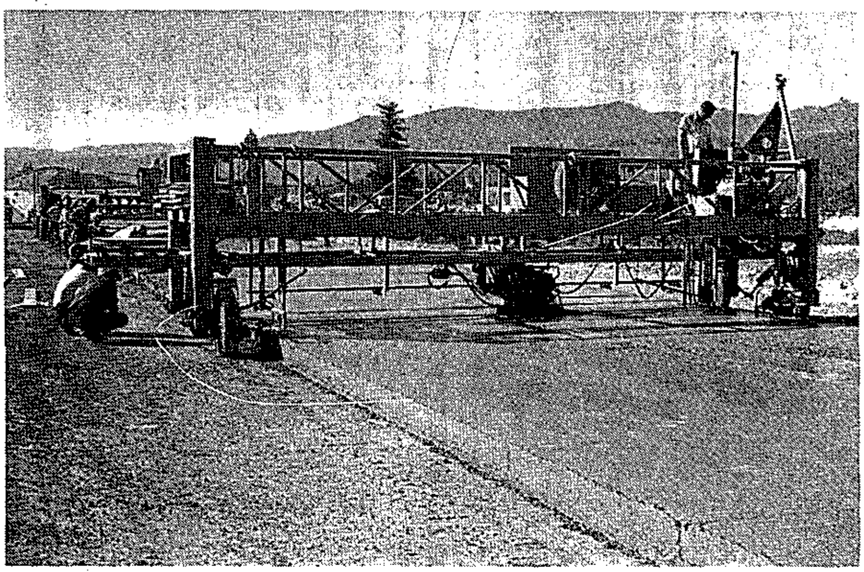

Figure 2. Plastic joint machine in operation.

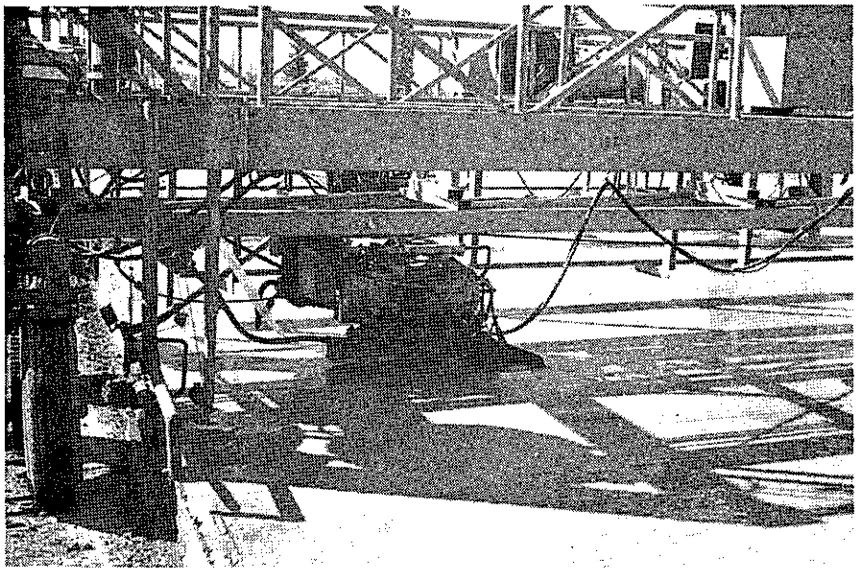

Figure 3. Inserting head on joint machine.

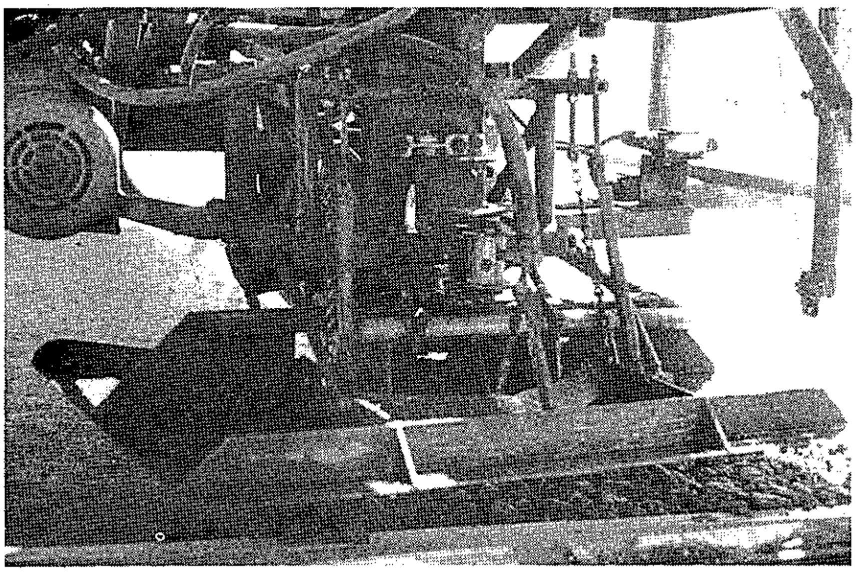

Figure 4. Vibrator and pan float on inserting head.

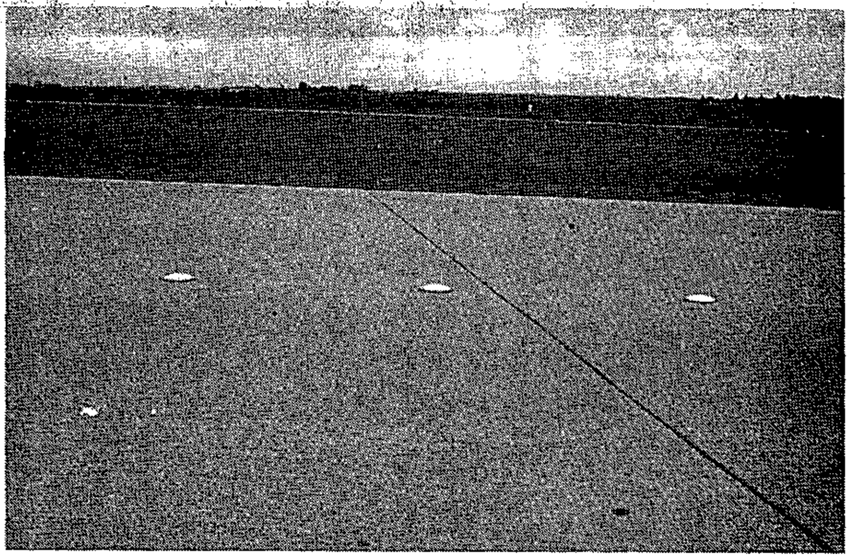

Figure 5. Rating "O". No spalling.

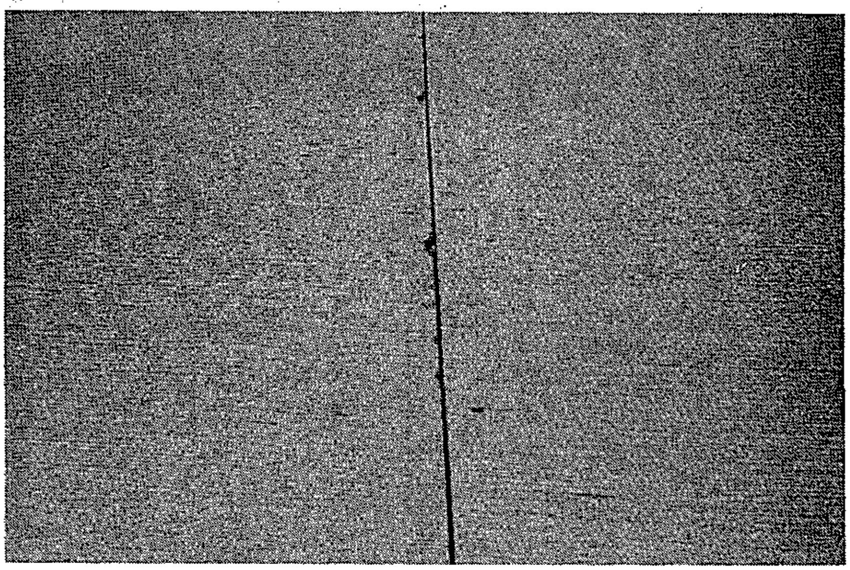

Figure 6. Rating "1". Minor spalling.

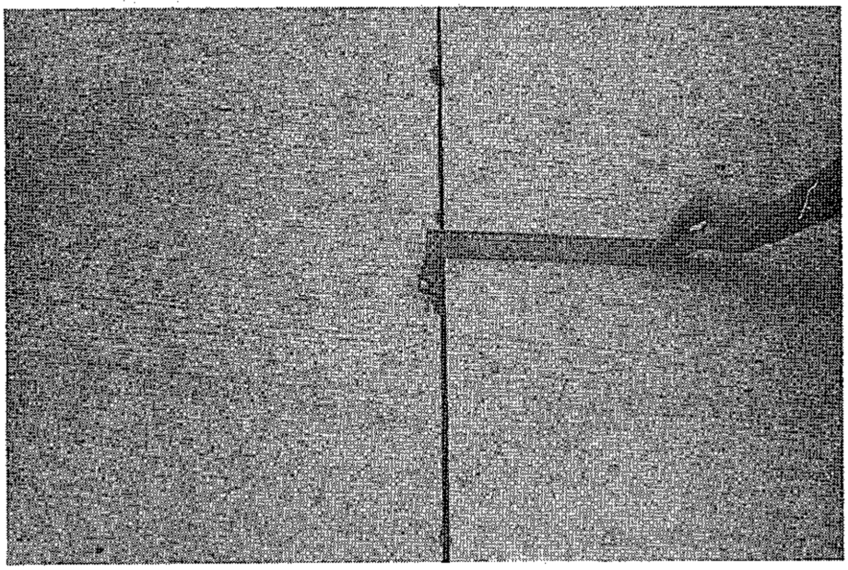

Figure 7. Rating "2". Moderate spalling.

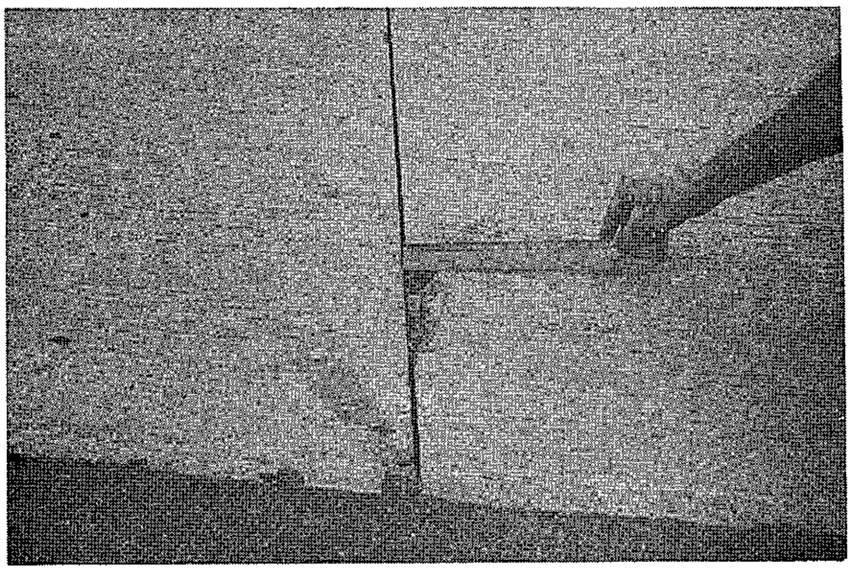

Figure 8. Rating "3". Major spalling.

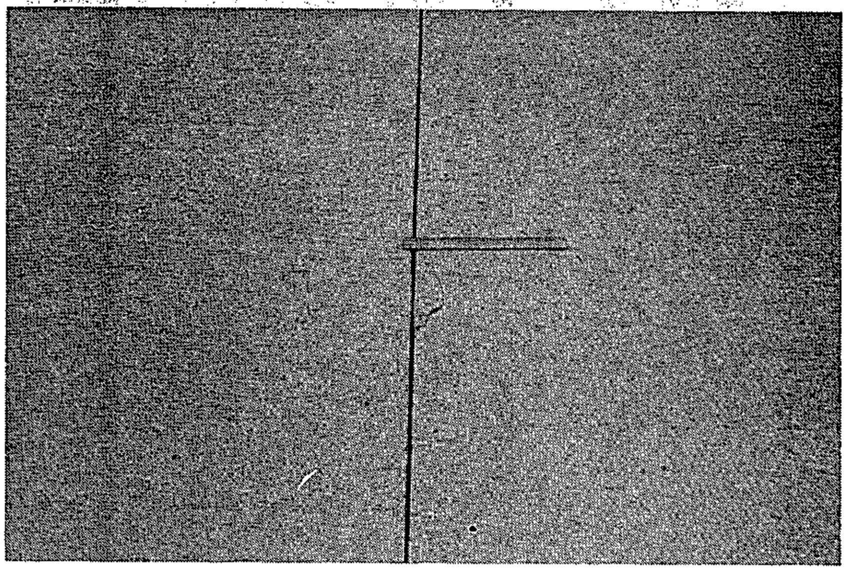

Figure 9. Rating "X". Incipient spalling.

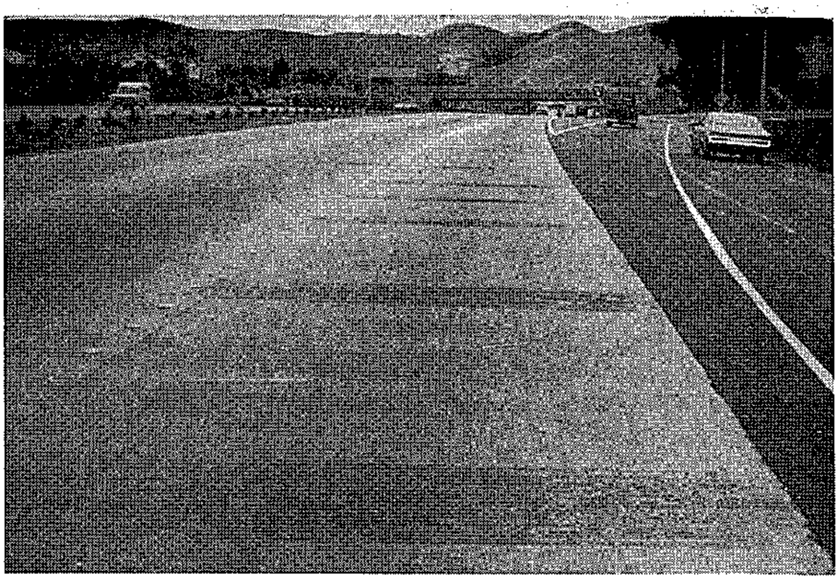

Figure 10. Grinding at transverse plastic insert joints.

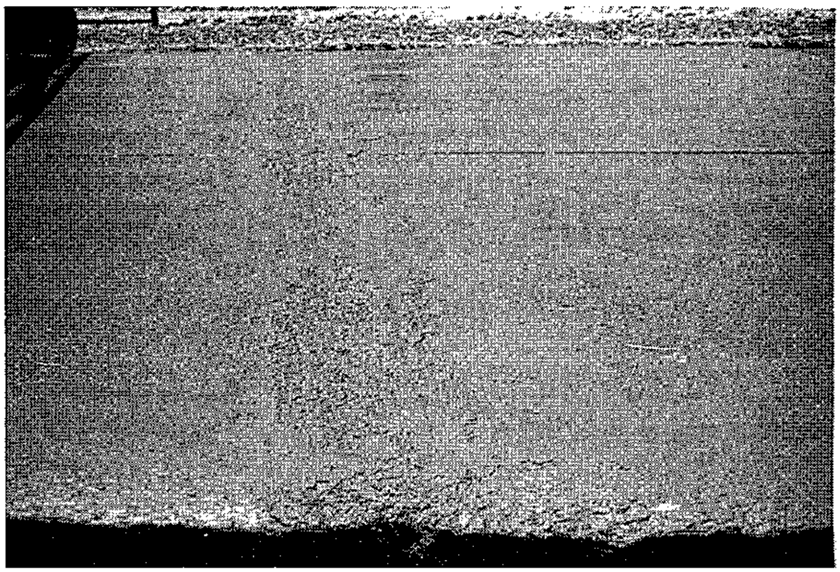

Figure 11. Edge slump at transverse plastic insert joint.

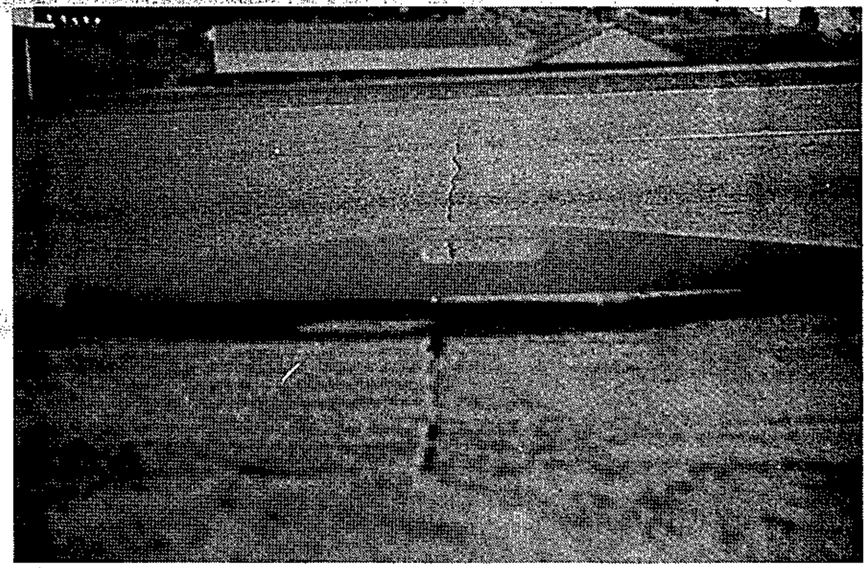

Figure 12. Bump at plastic insert joint.

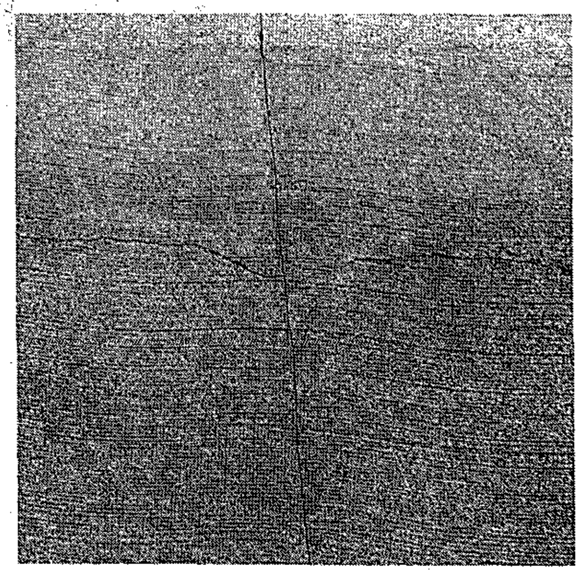

Figure 13. Displacement of longitudinal insert.

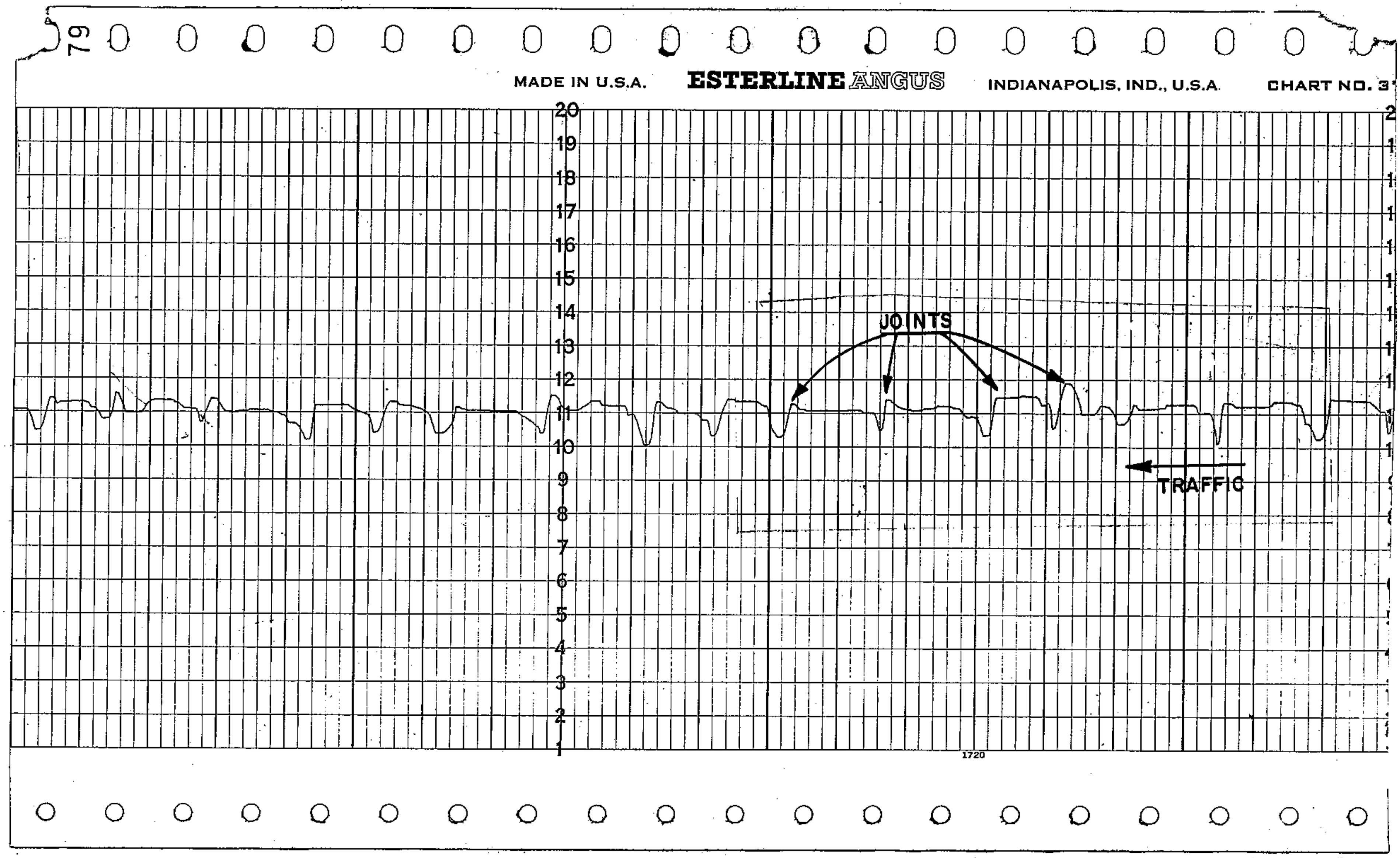

Figure 14. Graph of pavement showing roughness caused by joint inserter

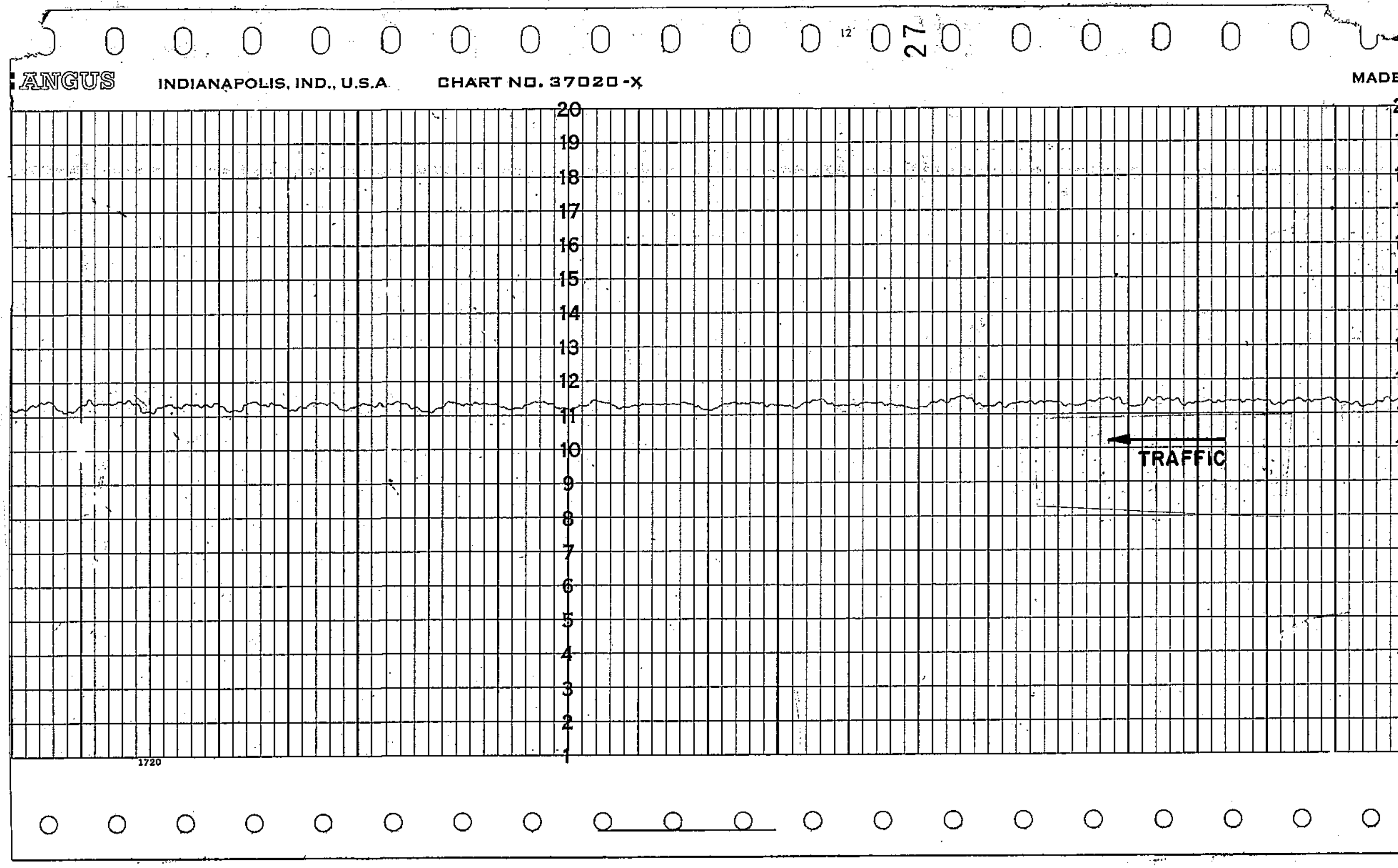

Figure 15. Graph of smooth pavement.

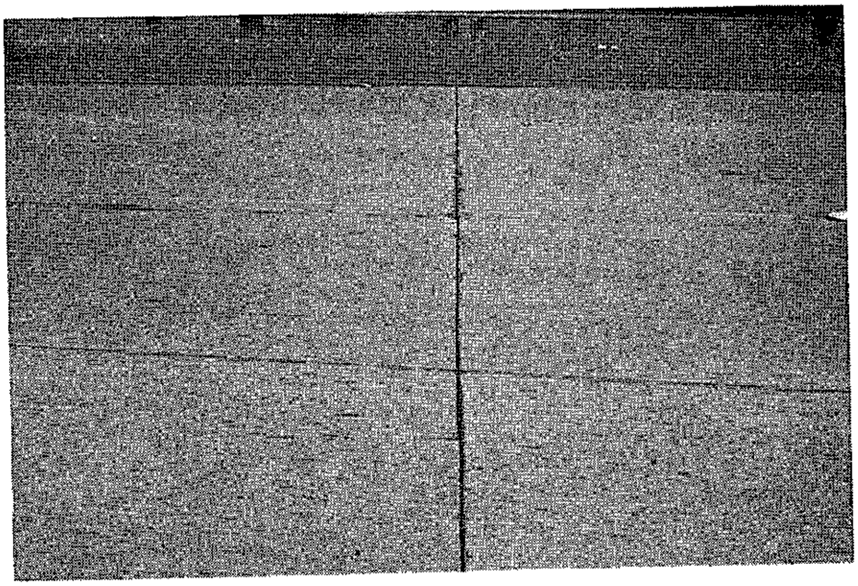

Figure 16. Ravelling of sawed joint.

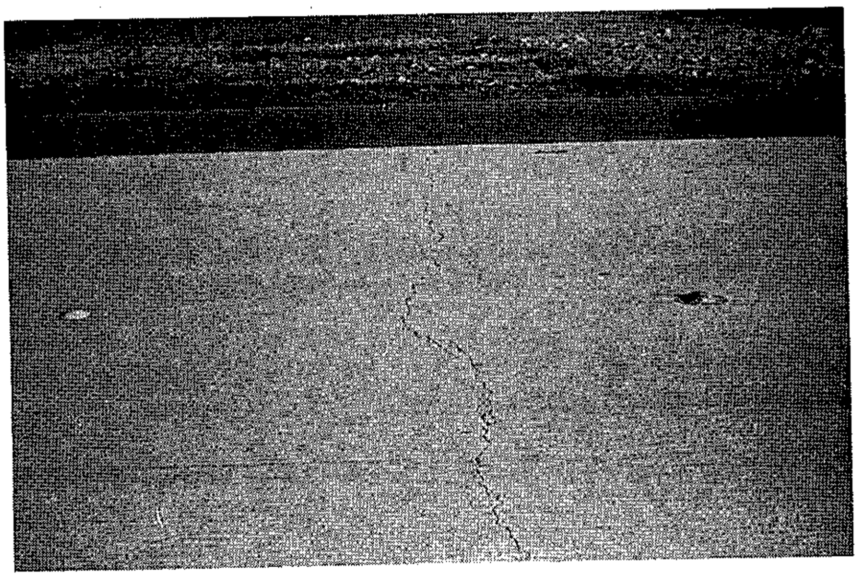

Figure 17. Random crack on sawed joint project.

APPENDIX

PROPOSED STANDARD SPECIFICATIONS FOR WEAKENED PLANE JOINTS

(This proposed specification has been reviewed by several members of the concrete paving industry in California and has been generally well received. It is still considered tentative and subject to further revision.)

40-1.08B - Weakened Plane Joints

Longitudinal joints at traffic lane lines and transverse weakened plane joints shall be formed at the locations shown on the plans either by cutting a groove in the pavement with a power driven saw, or by inserting a plastic strip in the fresh concrete.

40-1.08B (1) Sawing Method

Saw cuts shall be made to a minimum depth of 0.17-foot and the width shall be the minimum possible with the type of saw being used, but in no case shall exceed 0.02-foot.

The time of sawing joints shall be the responsibility of the contractor. The contractor shall exert every possible effort to prevent volunteer cracking. To achieve this, the sequence of sawing may be varied, water may be applied to cool the pavement surface after the pigmented curing seal is placed, or other measures not detrimental to the surface of the pavement may be utilized.

In lieu of the conflicting provisions of Section 90, the contractor shall bear the cost of applying cooling water.

Volunteer cracks that occur during the first 10 days following paving will be repaired as specified in Section 40-1.08B (3).

Excessive ravelling or tearing of the concrete adjacent to the saw cut, caused by sawing when the concrete is too green, will be repaired as specified in Section 40-1.08B (3). Excessive ravelling shall be defined as more than one foot of ravelling which exceeds 0.04-foot in width in a 12-foot lane, or more than three feet of ravelling which exceeds 0.01-foot in width in a 12-foot lane.

Spalls exceeding 0.04-foot in width, and greater than 0.3-foot long that occur at joints or at cracks before the pavement is open to public traffic, shall be repaired at the contractor's expense, as specified in Section 40-1.08B (3).

40-1.08B (2) Plastic Insert Method

Transverse weakened plane joints may be formed by placing a continuous strip of plastic or other material which will not react adversely with the chemical constituents of the concrete or bond with the concrete. The strip shall have a minimum thickness of 0.013-inch and a width of not less than 0.16-foot nor more than 0.18-foot. The joint material shall be placed in such manner that the top of the strip is not above nor more than 0.02-foot below the finished surface of the concrete. The joint material shall not be deformed from a vertical position, either in the installation or in the subsequent finishing operations performed on the concrete. Final alignment of the strip shall conform to that shown on the plans for transverse weakened plane joints and shall not vary more than 0.1-foot from the edge of a 12-foot straightedge. Splices in the joint material will not be permitted.

The transverse plastic insert joints shall be installed in such a manner as to not displace longitudinal plastic insert joints more than 0.2-foot.

The strip shall be placed by means of a mechanical installation device which shall vibrate the plastic concrete sufficiently to cause an even flow of concrete about the joint material. After installation of the joint material, the concrete shall be free of segregation, rock pockets, or voids. The finished concrete surface on each side of a joint shall be in the same plane, as determined by a 4-foot long straightedge. Any discernible deviations from the straightedge shall be corrected by grinding in accordance with Section 42.2, Grinding.

Volunteer cracks that occur during the first 10 days following paving, and spalls greater than 0.3-foot long that occur at joints or at cracks before the pavement is open to public traffic, shall be repaired at the contractor's expense, as specified in Section 40-1.08B (3).

Longitudinal weakened plane joints at traffic lane lines in multilane monolithic concrete pavement may be formed by placing a continuous strip of plastic or other material which will not react adversely with the chemical constituents of the concrete. The joint insert material shall be of such width and character that when placed vertically in the concrete, it will not bond with the concrete and will form an effective weakened plane joint of 0.17-foot minimum depth. The joint material shall be inserted with a mechanical device that places the material in a continuous strip, except where intervening structures break the continuity of paving. Splices in the joint material will be permitted providing they are effective in maintaining the continuity of the joint material as placed. The joint material shall be placed in such manner that the top of the strip is not above nor more than 0.01-foot below the finished surface of the concrete. The joint material shall not be deformed from a vertical position, either in the installation or in subsequent finishing operations performed on the concrete. The alignment of the finished joint shall be uniformly parallel with the center line of the pavement and shall be free of any local irregularity which exceeds 0.04-foot, measured from a 12-foot straightedge, except for normal curvature of center line alignment and the displacement permitted by the installation of transverse insert joints. The mechanical installation device shall vibrate the concrete during placement of the strip sufficiently to cause the concrete to flow evenly about the joint material. After installation of the joint material, the concrete shall be free of segregation, rock pockets, or voids, and the finished concrete surfaces on each side of the joint shall be in the same plane.

40-1.08B (3) Repair of Defective Pavement Slabs and Joints

The intent of this section is to provide working weakened plane joints at their original planned location. Corner breaks, volunteer cracks, spalls, and ravelling or tearing of joints shall be repaired as specified hereinafter at no cost to the State, and shall be accomplished prior to opening to public traffic.

Slabs with corner breaks shall be repaired by injecting with epoxy under pressure as provided hereinafter.

Volunteer cracks that do not cross planned weakened plane joints or that cross such planned joints but do not follow their alignment, shall be repaired by injecting with epoxy under pressure except as provided herein. Where the volunteer crack crosses a planned joint, protective measures must be taken to prevent the entry of epoxy into the planned joint. Where a volunteer crack meets a planned weakened plane joint and proceeds along the joint, only the volunteer crack portion of the joint shall receive the injected epoxy and protective measures must be taken to prevent entry of injected epoxy into the working portion of the planned joint. Epoxy injection shall be completed within 30 working days from the date pavement is placed.

In making epoxy repairs, a surface seal shall be applied to prevent the escape of epoxy and entry ports shall be placed at intervals along the seal to allow filling of the entire crack. Surface seal material shall be such as to allow removal without damaging the texture of the pavement surface. Epoxy shall be applied using in-line mixing type equipment. Pressure pots will not be allowed. The epoxy shall conform to the requirements of State Specification 731-80-27. The contractor shall provide a minimum of one core for each 100 linear feet of epoxied crack to provide evidence of satisfactory injection procedures. Such cores shall extend through the entire depth of pavement and include the full depth of the crack. The exact number and location of cores shall be determined by the Engineer. Cracks not fully filled with epoxy must receive additional injection of epoxy and may require additional cores for verification as determined by the Engineer.

If, in the opinion of the Engineer, certain volunteer cracks can serve in lieu of planned joints, then such volunteer cracks shall be routed and sealed with joint sealant. Also, volunteer cracks through the full depth of pavement that cross the entire paving width and are wider than 1/16-inch are not to be injected with epoxy but shall be routed and sealed with joint sealant. The width of crack shall be determined by measurements made at approximate 4-foot intervals along the crack. The exact location and number of measurements will be made during the morning hours before crack widths are reduced by thermal expansion of the concrete.

The top of the crack shall be routed to a minimum depth of 3/4-inch and to a width not less than 3/8-inch by means of an approved routing machine. The sidewalls of the cut shall be vertical. The routing machine shall be capable of closely following the path of crack and of widening the top of the crack to the required section without spalling or otherwise damaging the concrete. Loose concrete and cuttings shall be removed and the groove thoroughly cleaned by flushing with water and air, then sealed. Joint sealant shall conform to State Specification 701-56-39 (either machine grade or hand mixed), or Federal Specification SS-S-1401, with the following amendments:

Test	Requirement
1. Compatibility with asphalt.	Requirement waived.
2. Flow at 150°F	No flow.
3. Resilience. All samples cured 96 hours at 75±7°F. Oven aged sample cured 24 hours extra at 158±2°F.	50 percent, minimum
4. Bond to concrete, failure.	1/4-inch maximum on all samples.
5. Artificial weathering test. Interim Federal Specification SS-S-00200c, paragraph 4.3.3.14.	Shall not flow, show tackiness, presence of an oil-like film or reversion to a mastic-like substance, formation of either intact or broken, form internal voids, surface crazing or cracking, hardening or loss of resilient rubber-like properties.
6. Penetration	1.30 centimeters, maximum

In addition, the joint sealant shall be a liquid which remains fluid until after it has been heated to approximately 250°F and allowed to cool.

Sealant shall be placed a minimum of 1/2-inch in depth and shall be left 1/8-inch to 1/4-inch below the top surface of the pavement.

Spalls and ravelled or torn joints shall be repaired by removing all weak and fractured concrete and cleaning surfaces to receive patch. A prime coat of epoxy resin binder, State Specification 701-80-46, shall be applied to the area to receive the patch using a stiff bristled brush. Placement of portland cement concrete or epoxy resin concrete (or mortar) shall immediately follow the application of the prime coat. An insert or other medium shall be used to prevent bonding of the two sides of a planned joint.